Research Report 1497

The Effects of Small Group and Individual Computer-Based Instruction on Retention and on Training Lower Ability Soldiers

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The effects of having various numbers of soldiers at a terminal for computer-based instruction (CBI) in a procedural task were examined. Soldiers in each of two experiments were trained to use the Communications-Electronics Operating Instructions (CEOI) extracts. Twenty-four soldiers participated in Experiment 1. Eight were nonsystematically assigned to each of three conditions: "GRP," or four at a terminal; "PR," or two at a terminal; and "IND," or one at a terminal. All soldiers took a pretest, a posttest immediately after training, and a second posttest 2 weeks later.

Thirty-four soldiers, who were in sustainment training, participated in Experiment 2. Twelve were in the GRP condition, 10 in PR, and 12 in IND. All were pretested and took three posttests: one immediately after training, another 2 weeks later, and another 8 weeks after training.

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19. ABSTRACT (Continued)

The results of the two experiments suggested that, for both low-ability and other soldiers, the GRP and PR presentations were more cost-effective. Further, soldiers in GRP and PR conditions retained more information than those in IND conditions.

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Education and Training

FOREWORD

The Army is continually challenged to provide effective training with little or no increase in resources. This report provides the results of training four, two, or one soldiers at a terminal for computer-based instruction (CBI) Results are provided for soldiers of different ability levels.

The research was part of the Army Research Institute's Fort Knox Field Unit's research program to apply new technologies to armor skill training needs. It was performed in accordance with a memorandum of agreement among the U.S. Army Armor School (USAARMS), the U.S. Army Training and Doctrine Command (TRADOC), and the U.S. Army Research Institute (ARI), Subject: Continuation of the Training Technology Field Activity at Fort Knox, KY, signed March 87. These final results were presented to the Army School in August 1988. The recommendations cited in this report will be applied to armor training at Fort Knox, Kentucky. This report also contains information that will be useful to other military implementations of CBI.

EDGAR M. JOHNSON
Technical Director

THE EFFECTS OF SMALL GROUP AND INDIVIDUAL COMPUTER-BASED INSTRUCTION ON RETENTION AND ON TRAINING LOWER ABILITY SOLDIERS

EXECUTIVE SUMMARY

Requirements:

A continuing challenge to the Army is to provide effective training with little or no increase in resources. One training innovation being explored by Fort Knox's Training Technology Field Activity (TTFA) is small group presentation of computer-based instruction (CBI). Previous research (Shlechter, 1987a) indicated that group presentation of CBI would help the Army meet its instructional challenge. Questions remained, however, about the relative effectiveness of small group CBI in helping students retain the acquired information and about its effectiveness for training lower ability soldiers.

Procedure:

Two experiments were conducted. Twenty-four soldiers participated in Experiment 1. These soldiers received acquisition training on how to use the Communications-Electronics Operating Instructions (CEOI). Eight soldiers were nonsystematically assigned to one of three CBI conditions: "GRP" (four at a terminal); "PR" (two at a terminal); and "IND" (one at a terminal). These soldiers took a pretest, an immediate posttest, and a delayed posttest. The interval between the immediate and delayed posttests was 2 weeks.

Thirty-four soldiers, who were in sustainment training, participated in Experiment 2. Twelve were in the GRP condition, 10 in PR, and 12 in IND. An equal number of high, medium, and lower ability soldiers was assigned to each training condition. These soldiers took a pretest, an immediate posttest, and two delayed posttests. The interval between the immediate and the first delayed posttest was 2 weeks, and the interval between the two delayed posttests was 6 weeks.

Findings:

GRP soldiers completed the courseware in less time than did the PR and IND training soldiers. Also, the GRP and PR soldiers

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retained more information than the IND soldiers. The notion that group CBI was more effective than individual CBI for training lower ability soldiers also was supported.

Utilization of Findings:

These findings provide support for using group CBI in military training courses. This report also contains information that will be useful to military and civilian personnel engaged in developing, implementing, and investigating CBI programs.

THE EFFECTS OF SMALL GROUP AND INDIVIDUAL COMPUTER-BASED INSTRUCTION ON RETENTION AND ON TRAINING LOWER ABILITY SOLDIERS

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THE EFFECTS OF SMALL GROUP AND INDIVIDUAL COMPUTER-BASED INSTRUCTION ON RETENTION AND ON TRAINING LOWER ABILITY SOLDIERS

INTRODUCTION

A continuing challenge to the Army is providing effective training with little or no increase in resources. This challenge emphasizes the need to exploit available technologies. To meet this need, the Army Training and Doctrine Command, the U.S. Army Armor Center, and the Army Research Institute (ARI) have established a joint Training Technology Field Activity (TTFA) at Fort Knox. The mission of TTFA is to identify, develop, and implement a variety of training innovations.

One training innovation is small group presentation of computer-based instruction (CBI). The research evidence has indicated that group CBI presentation is more cost effective than individualized CBI (See Dossett & Hulvershorn, 1983; Okey & Majer, 1976; Johnson, Johnson, & Stanne, 1986; Shlechter, 1987a.) Shlechter, for example, found that soldiers receiving small group CBI (four at a terminal) completed the computer lessons in less time than and with the same achievement scores as did soldiers receiving individual CBI. Also, the group-training soldiers needed less instructor guidance than did the individual training condition soldiers. Group CBI thus allowed more soldiers to receive training and appeared to have no adverse effects on learning.

Shlechter's (1987a, 1987b) research did not involve a traditionally cooperative learning program. His purpose was to examine the effectiveness of group learning situations as typically employed in Army training programs. The primary instructors for this course did not spend a considerable amount of time structuring this learning situation to force the soldiers to interact with each other. Soldiers were neither encouraged nor discouraged from interacting with each other, nor were they provided a group reward for completing the task. Shlechter's previously discussed conclusions thus were a result of group CBI presentation rather than a result of a cooperative CBI program.

Before TTFA can recommend implementing group presentation of CBI materials, the effects of group CBI upon soldiers' retention must be examined. One function of training is to insure that long-term changes occur within the students. The military is especially interested in troops' retaining skills and knowledge for an indefinite period of time (Farr, 1986; Shlechter, 1986).

Even though similar learning rates have been found for subjects in group and individual CBI programs, differences may exist in their ability to retain the information.

An individual's ability to retain information may not be tied to the initial amount of acquisition (e.g., Baddeley, 1986; Baker, 1979; Edwards & Middleton, 1986; Hagman, 1983; Toglia, Shlechter, & Herrmann, 1984). Hagman, for example, found that the subjects who had the best acquisition scores did not always exhibit the most retention. Also, Baker has suggested that students' retention of class material is tied to their comprehension of the material rather than to the amount of material learned. A student who understood the principles behind mathematical formulas should for example, retain this information better than the student who remembered the formulas without knowing the underlying principles.

The instructional research literature (e.g., Bargh & Schul, 1980; Hagman & Hayes, 1986; Johnson & Johnson, 1983, 1986; Webb, 1982) has suggested that small group instruction is more beneficial than individual instruction for helping students retain the material. Explaining material allows the teacher to develop a better fundamental grasp of the material because the teacher has to reorganize and clarify the material on the spot (Bargh & Schul, 1980 as cited by Webb, 1982). Schallert and Kleinman (1979) have suggested that a teacher is better than any instructional text for tailoring the message to fit and promote students' level of understanding.

Only Carrier and Sayles (1987) have directly examined the effectiveness of group CBI use versus individual CBI use upon students' retention abilities. Carrier and Sayles found that there were similar retention levels of conceptual information for students under paired and individual CBI training conditions. The one week retention interval used by Carrier and Sayles might not have been sufficient for finding retention differences among the subjects. An effect for group training might have been found with more students in a group. More substantial verbal interactions should be found for groups with four members than those with two members. Hagman and Hayes (1986) have shown that for cooperative learning situations maximum learning benefits occur with four in a group. Finally, students' forgetting of a conceptual learning task might not be the same for the procedural learning tasks, which are prevalent in Army training programs. Tulving (1984), for example, has suggested that remembering procedural and semantic (conceptual) information involves the use of different memory systems. The relative effectiveness of group versus individual CBI instructional programs for military training purposes, therefore, needs to be examined.

Using group CBI for training lower ability students must also be examined. The military is concerned with developing instructional programs appropriate to lower ability students (Farr, 1986). Dansereau (1983) and Dossett and Hulvershorn (1983) have suggested that lower ability subjects would learn more through

peer-based CBI than through individual CBI. Neither investigation, however, compared the effects of small group and individual instruction for training lower ability students.

Morrison (1987) made such a comparison, and found that paired peer-training was not the optimal instructional mode for training military trainees with lower General Technical (GT) scores. Morrison and Webb (1982), however, have suggested that the performance of lower ability students might be improved by pairing them with higher ability soldiers: the higher ability students would be able to explain the material to the lower ability students. Also, group CBI with four subjects at a terminal might be the optimal mode for training lower ability students. As previously mentioned, Hagman and Hayes (1986) suggested that learning effects for peer instruction are most pronounced with four in a group.

Purpose

The present investigation was designed to examine the effects of small group (four at a terminal) versus individual CBI upon retention abilities and lower ability soldiers. Group CBI was expected to be more beneficial than individual CBI for promoting retention and for training lower ability students. The results of this investigation also would provide information relevant to Shlechter's (1987a, 1987b) previous findings about the cost-effectiveness of group CBI.

EXPERIMENT 1

Method

Subjects. Twenty-four subjects from the Armor One Station Unit Training (OSUT) program at Fort Knox, Kentucky participated in this experiment. The soldiers were inexperienced with the tasks used in this investigation.

Training Conditions. Eight soldiers were non-systematically assigned to each of three training conditions-"GRP" (four per terminal); "PR" (two per terminal); and "IND" (one per terminal). The PR condition was included to explore the effects of increasing the number of soldiers at a terminal. As previously discussed, there was some evidence that four per terminal would be more successful than two per terminal. Also, the military instructors at Fort Knox had expressed an interest in determining the most desirable number of trainees per terminal.

Because of an inability to obtain the soldiers' personnel records, their GT scores were obtained after they completed the computer lesson. The group training condition consequently did

not have any lower ability soldiers. This and other demographic characteristics of the soldiers in the three training conditions are shown in Table 1.

Hardware and Courseware. A Microcomputer Time-Shared Computer-Controlled Information Television (MicroTICCIT) System II was used in this investigation. Wilson (1984) described the MicroTICCIT system as "state-of-the-art" technology with student terminals consisting of an IBM personal computer, a SONY color monitor, a light-pen responding mechanism, and a high speed communications link to the host terminal.

The CBI courseware was designed to train noncommissioned officers how to use the Communications-Electronics Operation Instruction (CEOI) extracts. CEOI is a system developed by the U.S. Army to insure the reliability and security of tactical communications. This CEOI courseware consisted of six units. Unit I provided an overview of the course and the CEOI. The next five units covered the following CEOI tasks:

1. Securing the booklets
2. Locating call-signs and suffixes of designated units
3. Locating radio frequencies of designated units
4. Encoding and decoding messages in the standard military terminology
5. Finding unit item identifiers
6. Finding the proper reply authentication code for any randomly generated two letter challenge code
7. Encrypting grid coordinates

Each unit provided text and exercises on the procedures for performing each task. The exercises involved the soldier(s) in entering the requested information with a light-pen onto the screen. The soldiers had to make three correct responses to each set of exercises. There were two to ten sets of exercises per unit. After each wrong response to an exercise, the soldier(s) received an additional item. This courseware was found to be an effective method for CEOI training (Shlechter, 1987a).

Instruments. Paper and pencil pretests, immediate posttests, and delayed posttests were used. The tests were modifications of the standard Army end-of-course tests for CEOI training. The Army would not allow TTFA to use the actual Army tests for this

Table 1

Experiment 1: Demographic Characteristics of Soldiers in the three Training Conditions.

	IND Condition (n=8)	GRP Condition (n=8)	PR Condition (n=8)
Military Grade	3-E1s 3-E2s 2-E3s	4-E1s 2-E2s 2-E3s	3-E1s 2-E2s 2-E3s
Mean no. of months in service	5.13	8.88	6.88
Number of Ss with previous CEOI experience	1.00	2.00	3.00
Mean no. of previous CEOI use	.25	.63	.88
Number of Ss using CEOI between sessions	1.00	3.00	3.00
Mean no of intervening CEOI use	.25	.75	.50
Highest educational level			
GED	0	2	2
High School Diploma	5	4	5
Some college	2	2	2
College Grad	1	0	0
Average GT scores	107	116	107
Number of soldiers with GT scores of 100 or less	3	0	1

investigation. Each test consisted of 13 items which measured different aspects of the instructional materials. Measures were taken to make the forms of the test similar and to eliminate differences in difficulty. The encoding items for various tests had, for example, the same kind and number of messages. These tests were judged to be similar in form and content by three judges familiar with the CEOI. The tests are in Appendix A.

A two-part background questionnaire was also created. Part A assessed the soldiers':

1. Pay grade
2. Months in service
3. Months assigned to armor duty
4. Months as a Tank Commander (TC)
5. Frequency of previous CEOI use
6. Years of formal education

Part B of the questionnaire asked the soldiers to indicate the amount of their CEOI practice between the immediate and delayed posttests, because amount of practice could have aided their retention.

Procedure. The procedures for this research were the same as those used by Shlechter (1987a, 1987b). To make these procedures similar to the procedures used in the classroom, four guidelines were followed:

1. Soldiers were neither encouraged nor discouraged from discussing the materials.
2. Soldiers completed the courseware as designed (i.e., additional practice for each wrong response to the practical exercises).
3. Group rewards for completing the computer lesson were not provided.
4. Individual tests rather than group tests were administered.

Soldiers first were administered Part A of the background questionnaire and the pretest. They had 15 minutes to complete Part A of the background questionnaire and 40 minutes to complete the pretest. All soldiers completed the instruments in the allotted time.

The soldiers then completed the computer lesson. They were given 5 minute breaks after approximately each 30 minutes of instruction. Trained observers recorded the following information while the soldiers completed these lessons:

1. Frequency of responses (providing the answer to the practical exercises from the CEOI)

2. Frequency of wrong responses

3. Frequency of proctor prompting

4. Frequency of helping behavior

5. Time to complete the CEOI lessons

Observers were also instructed to describe each interaction that occurred within the GRP and PR terminal groups.

A civilian ARI employee knowledgeable in the CEOI tasks served as proctor, and was available to help the soldiers. This help was only provided when requested by the soldiers.

After completing the computer lesson, the solders were given the immediate posttest. They were administered the delayed posttest and then the Part B of the background questionnaire, two weeks after training. They had 40 minutes to complete each of the two posttests and 10 minutes to complete the questionnaire. All soldiers completed the instruments in the allotted time.

Training Procedures for the Observers. Four observers were used in this investigation. They were trained in the following ways:

1. A detailed set of instructions was given to each observer.

2. The experimenter discussed these instructions with each observer.

3. Each observer went through mock experimental sessions.

These sessions were completed when all observers went through a mock session without making any mistakes. The trainers emphasized the importance of refraining from helping or interfering with the soldiers' learning the CEOI materials.

Scoring Procedures. The tests were scored using a predetermined scoring scheme. Scored by two independent judges, each item was worth one point for getting the item totally correct, with 13 points as a perfect score for the entire test.

Partial credit was awarded for items with several components. The grid encrypting item, for example, consisted of eight bits of information. The soldiers received an eighth of a point for each bit correctly encrypted. Because most of the items did consist of several components, information about students' learning would have been lost had partial credit not been given.

Two judges also independently scored the observational data. As previously indicated, these data consisted of the frequencies of:

1. Group responses (two or more soldiers responded to a computer exercise)
2. Individual responses
3. Wrong responses
4. Helping behaviors
5. Proctor prompting

The judges also scored the soldiers' total time in minutes to complete the courseware.

Results and Discussion

The data will be discussed in the following order:

1. Summary of results for the Pretest, Immediate Posttest, and the Delayed Posttest
2. Pearson correlations between demographic data and test scores
3. Retention performance of GRP and IND soldiers
4. Learning efficiency data for the GRP and IND
5. Data for the GRP and PR conditions

Summary of Results for the Pretest, Immediate Posttest, and the Delayed Posttest. The mean pretest scores, immediate posttest scores, and delayed posttest scores for the soldiers in the three training conditions are presented in Figure 1. The mean times in minutes for soldiers in each training condition to complete the CEOI courseware are presented in Figure 2.

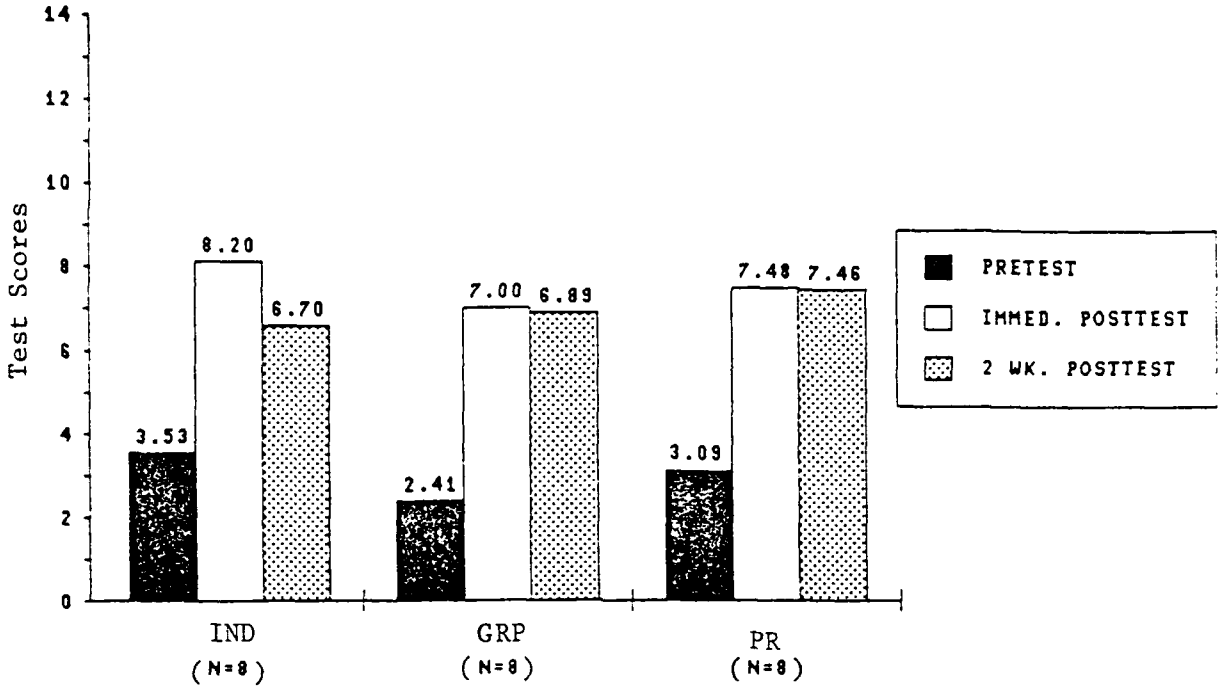

Figure 1. Experiment 1 mean scores on each test for the different testing conditions.

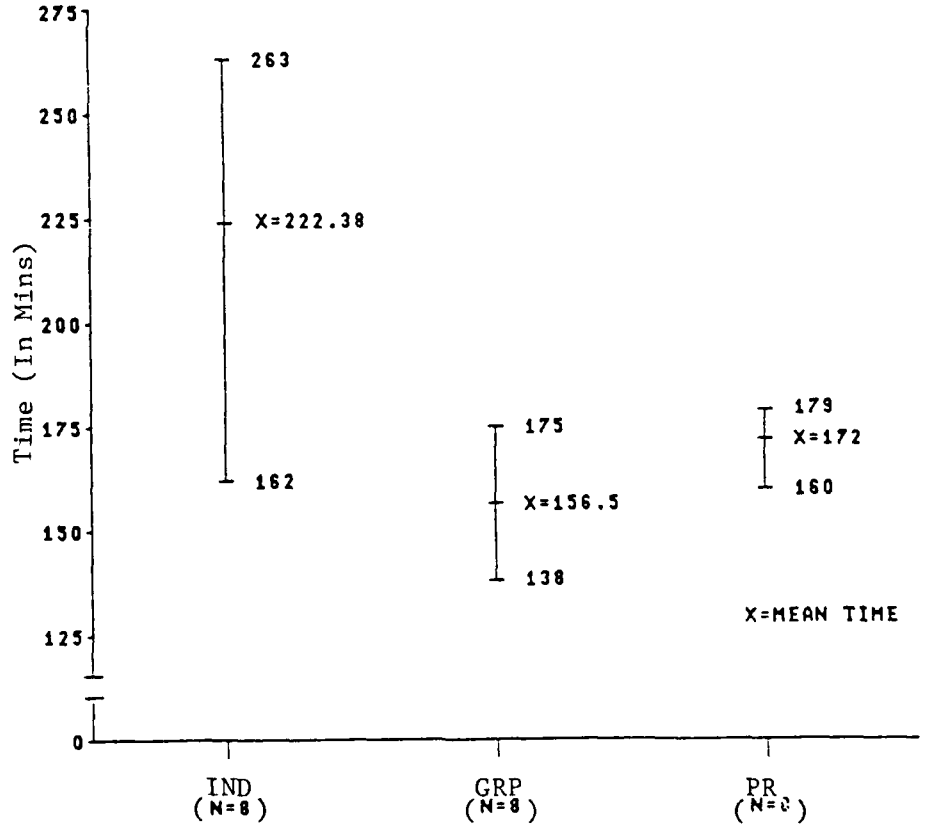

Figure 2. Experiment 1 range of times and mean times in minutes to complete the courseware.

Pearson correlations between demographic data and test scores. Pearson product-moment correlations were computed to examine the relation between soldiers' demographic data and scores on the various tests. The relation between the soldiers' demographic variables and their time to complete the courseware was not examined because these correlations would have mainly been a function of the variability in the individual soldiers' time data.

Statistically reliable correlations were found only between previous CEOI use and the soldiers' pretest scores ($r(22) = .55$, $p<.05$) and between the number of soldiers with previous CEOI experience and their pretest scores ($r(22) = .44$, $p<.05$). These significant correlations might be chance occurrences as 17 different correlations were computed. Results of the correlations between the different background variables and the cited performance measures are in Appendix B.

Retention Performance of GRP and IND Soldiers. The delayed posttest score minus immediate posttest score was the retention score calculated for each soldier. The higher the retention score meaning better the retention. The mean retention scores were -.105 for the GRP soldiers and -1.50 for the IND soldiers. This difference was statistically reliable ($t(14) = 1.75$, $p<.05$). Group presentation of CBI materials led to a more lasting retention of the newly learned information than did individual presentation of the CBI materials.

The reported retention findings did not seem related to any demographic variables measured in this experiment. Statistically reliable correlations were not found between retention scores and the various demographic measures (see Appendix B). Statistically reliable correlations also were not found between retention scores and: (a) amount of reported practice between testing sessions and (b) amount of reported previous CEOI use. Also, differences in retention scores cannot be explained in terms of practice effects. The IND soldiers practiced more on the CEOI tasks in the CBI courseware than did the GRP soldiers. The IND soldiers averaged 12 more exercises than did the GRP soldiers.

The retention findings seemed to be a function of the cooperative learning among group members. There were several indications that such cooperative learning did occur: The observers reported that frequent discussions occurred at these terminals. Also, 50 incidences of helping behaviors were exhibited by the GRP soldiers. And over 55% of their responses to the exercises were provided by two or more soldiers.

Learning Efficiency Data for the GRP and IND Training Conditions. The learning efficiency data consisted of the following measures:

1. Time scores (time in minutes to complete the lesson) Achievement scores (immediate posttest scores)

2. Wrong responses to the exercises

3. Amounts of proctor assistance

A learning efficiency index for each training condition also was computed:

100 X (Achievement Score/Instructional Time) X number per terminal)

This learning efficiency index was derived from one created by Okey and Majer (1976). Learning efficiency indexes have been used to provide a global picture of the cost efficiency associated with a learning program (see Boldovici, 1987; Okey & Majer).

Learning efficiency indexes of 17.88 for the GRP condition and 3.65 for the IND condition were found. These results were a function of reliable difference ($t(14) = 5.44$, $p<.05$) in the soldiers' time scores. The IND soldiers averaged nearly 66 minutes more than the GRP soldiers (see Figure 2). The IND soldiers' learning times also were the most variable. A statistically reliable difference ($t(14) = .61$, $p>.05$) was not found in the soldiers' achievement scores (see Figure 1). The same learning rate (pretest scores minus posttest scores) was also found for the GRP soldiers (4.59) and individual training soldiers (4.63).

The learning efficiency data also showed that the IND soldiers needed more proctor assistance--37 requests as compared to two such requests for the GRP soldiers. The IND soldiers also averaged 17.5 wrong responses to the computer exercises as compared to an average of 5.5 for the GRP soldiers. The IND soldiers thus had more difficulty than did their GRP training counterparts in completing the CEOI courseware.

The learning efficiency data provided additional support to claims made by Okey and Majer (1976) and Shlechter (1987a; 1987b) about the relative efficiency of group CBI training: Group CBI appeared to be nearly five times more cost efficient than individual CBI. Group CBI also required fewer proctor interventions than did the individual presentation.

Data for GRP Versus PR Training. There were several indications that group CBI training was more efficient than paired CBI

training. Learning efficiency indexes of 17.88 for the GRP condition and 8.70 for the PR condition were found. These results were tied to statistically reliable ($t(14) = 2.40$ $p<.05$) difference between the soldiers' time scores. The PR soldiers averaged 16 minutes more than GRP soldiers (Figure 2). The PR soldiers also made more than twice as many wrong responses to the computer exercises as did their counterparts in the GRP condition (12.25 versus 5.5). And the PR soldiers requested help 10 times from the proctor as compared to two such requests from the GRP soldiers.

Noticeable differences between PR and GRP soldiers were, however, not found in the retention data. The average retention scores were -.105 for the GRP soldiers and -.07 for the IND soldiers.

Summary. The results of Experiment 1 provided additional support for implementing group CBI rather than individual CBI. Support also was provided for implementing group CBI over paired CBI.

Information was still needed about the effects of group CBI for training lower ability students. Information also was needed about the effects of group CBI for training experienced soldiers, because the courseware was intended for refresher or sustainment training of experienced noncommissioned officers in CEOI. Collecting sustainment training data also was important because the Army spends a considerable amount of time with such training. A second experiment was therefore conducted to examine the effects of group CBI for training lower ability soldiers and for sustainment training of experienced noncommissioned officers.

EXPERIMENT 2

Method

Subject. Thirty-six armor noncommissioned officers stationed at Fort Knox, KY were selected by the ARI's R&D Coordinator to participate in this study. The soldiers were in pay grades E5 and E6. They came from armor brigades at Fort Knox. Nearly all had previous CEOI, tank, and TC experience.

Training Conditions. Each unit was asked to send its troops with the highest and lowest GT scores to this experiment. Twenty-four soldiers with either GT scores of 115 or higher or GT scores of 100 or lower were sent. The remaining 12 had GT scores between 101-115. The 36 soldiers were then assigned based upon their GT scores to one of three training conditions-GRP, PR, or IND. Two soldiers assigned to the PR condition did not participate in this study.

Each condition consisted of a nearly equal distribution of soldiers with high, medium, and low GT scores. Lower ability soldiers were always matched with higher ability soldiers at the various terminals. The demographic composition of this sample is presented in Table 2.

Table 2

Experiment 2: Demographic Composition of the Three Training Conditions

	IND Condition (n=12)	GRP Condition (n=12)	PR Condition (n=10)
Military Grade	4-E5s 8-E6s	8-E5s 4-E6s	4-E5s 8-E6s
Mean no. of months in service	96.50	94.00	108.00
Mean no. of months with tank experience	79.00	44.50	39.00
Mean no. of months as TC	45.17	11.58	23.40
Number of Ss with previous CEOI exp.	11.00	10.00	7.00
Mean no. of previous CEOI	6.58	7.00	9.70
Highest educational level			
GED	2.00	2.00	0.00
High School Diploma	3.00	3.00	6.00
Some College	7.00	7.00	4.00
Mean GT scores	109.00	107.00	106.00
Number of Ss with GT scores of 100 or less	4.00	3.00	4.00

Procedure. Two procedural changes were made from Experiment 1: These soldiers were given delayed posttests after intervals of 2 weeks and 2 months. This retention interval was suggested by US Army Armor School doctrine on sustainment training for CEOI tasks (USAARMS, FC17-15-1, 1984). A second delayed posttest was created in the manner in which the other tests were created (see Appendix A). The second procedural change was that a new questionnaire was administered to examine the subjects' reported amounts of CEOI practice between the two delayed posttests.

Results and Discussion

The results will be presented and discussed in the following order:

1. Summary of results for the Pretest, Immediate Posttest, and the Delayed Posttests
2. Pearson correlations between demographic data and test scores
3. Retention performance of GRP and IND soldiers
4. Learning efficiency data for the GRP and IND soldiers
5. Data for the lower ability soldiers in the GRP and IND conditions
6. Data for the GRP and PR soldiers

Summary of Results for the Pretest, Immediate Posttest and Delayed Posttests. Five soldiers did not complete the retention tasks because they were transferred from Fort Knox. Nine GRP soldiers, ten IND soldiers, and nine PR soldiers completed the retention tasks. These soldiers' scores on the tests are presented in Figure 3. The demographic composition of these 28 soldiers is presented in Table 3.

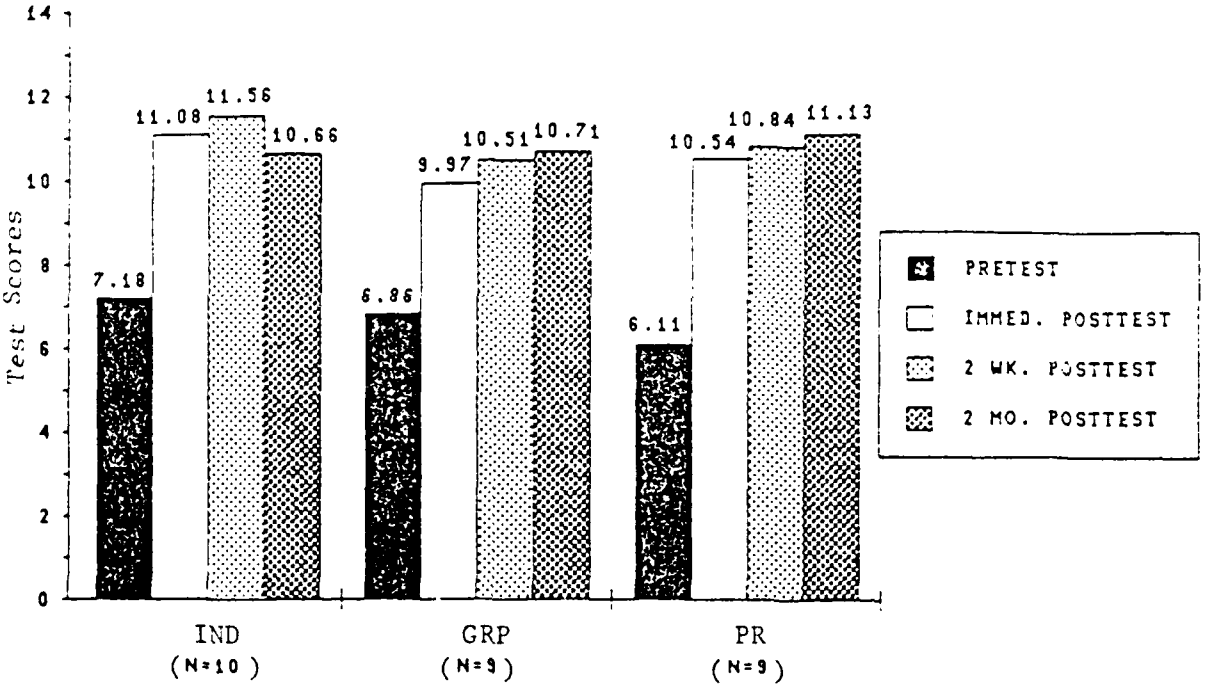

Figure 3. Experiment 2: Mean scores on the pretest and posttests for the sample of 28 soldiers.

Table 3

Experiment 2: Demographic Composition of the Retention Sample

	IND Condition (n=10)	GRP Condition (n=9)	PR Condition (n=9)
Military Grade	4-E5s 6-E6s	5-E5s 4-E6	3-E5s 6-E6s
Mean no. of months in service	100.00	106.67	105.44
Mean no. of months with tank exp.	76.20	52.00	41.33
Mean no. of months as TC	47.60	13.44	26.00
Number of Ss with previous CEOI experience	9.00	8.00	7.00
Mean no. of previous CEOI use	6.40	7.00	9.67
No. of Ss practice CEOI during first ret. interval	2.00	5.00	1.00
Mean no. of intervening CEOI use	.80	1.60	1.00
No. of Ss practice CEOI during second ret. interval	2.00	2.00	0.00
Mean no. of intervening CEOI use	.50	1.25	0.00
Highest educational level			
GED	2	1	0
High School	2	6	5
Some College	6	2	4
Mean GT scores	109	105	106

The instructional efficiency and lower ability data were examined in relation to the original sample. These soldiers' test scores are presented in Figure 4. Their mean time scores and ranges are presented in Figure 5. The lower ability soldiers' test scores are presented in Figure 6.

Pearson correlations between demographic data and test scores. Pearson correlations were computed between the soldiers' (n = 29) demographic data and their retention scores. Correlations were also computed between the soldiers' (n = 34) demographic data and their pretest and immediate posttest performance. A significant correlation ($r(32) = .46$, $p<.05$) was found only between the GT scores and pretest scores. This significant correlation might have been a chance occurrence as 24 different correlations were computed. The other correlations are presented in Appendix C.

Retention Performance of GRP and IND Soldiers. The retention data for the GRP and IND soldiers are shown in Figure 3. Here it can be seen that the average retention scores for the 2 week interval between the immediate and the first delayed posttest were .54 for the GRP soldiers and .48 for the IND soldiers. A negative retention score (-.90) was found, however, for the IND soldiers for the 6 week interval between the two delayed posttests. The GRP soldiers' average score was .20 for this 6 week retention interval. This difference of over a point in the soldiers' retention scores was nearly statistically reliable ($t(16) = 1.63$, $p<.07$).

The retention findings did not seem related to any demographic variables measured in this experiment. As reported, statistically reliable correlations were not found between the soldiers' retention scores and the different demographic measures. Also, the retention scores cannot be explained in terms of practice. The IND soldiers averaged 8.67 more practical exercises than did the GRP soldiers.

The superior retention of the GRP soldiers may have been the result of cooperative learning. There were several indications that such cooperative learning did occur. Frequent discussions occurred at the GRP terminals: Thirty-two incidences of helping behaviors were exhibited by the GRP soldiers, and more than 40% of their responses to the practical exercises were provided by two or more soldiers.

Learning Efficiency Data for the GRP and IND Soldiers. Recall that the learning efficiency data consisted of:

1. Learning efficiency indexes

2. Time scores (time in minutes to complete the lesson)

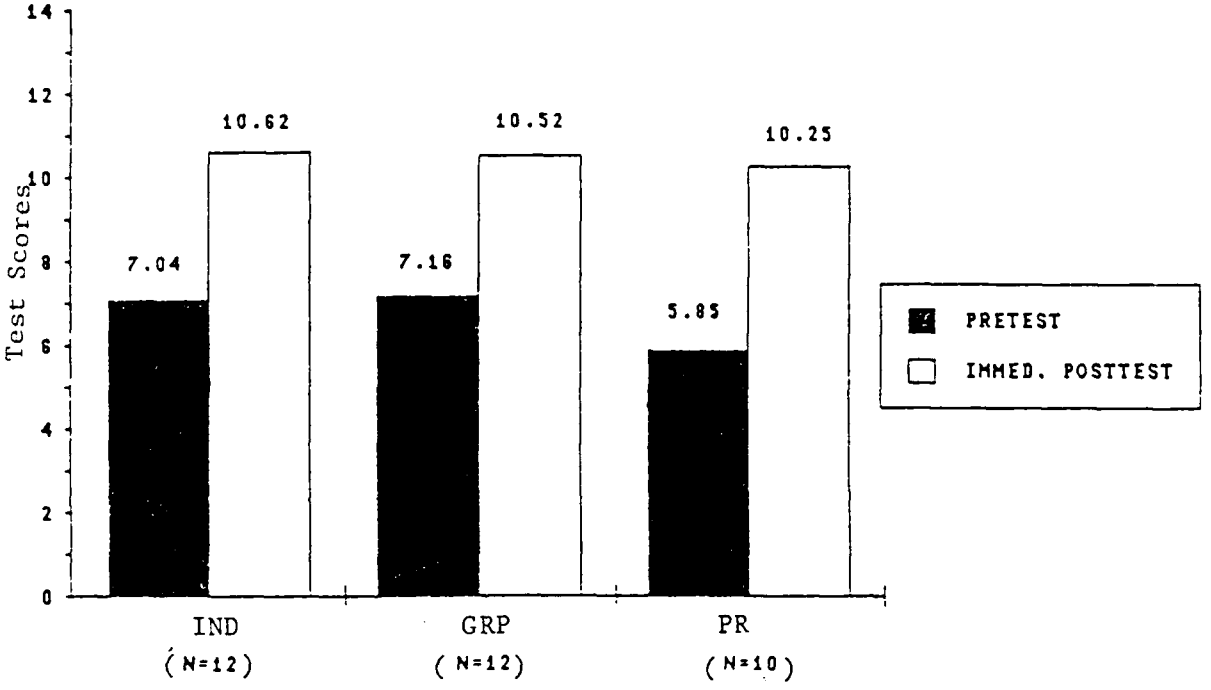

Figure 4. Experiment 2 mean pretest and immediate posttest scores for the 34 soldiers who completed the courseware.

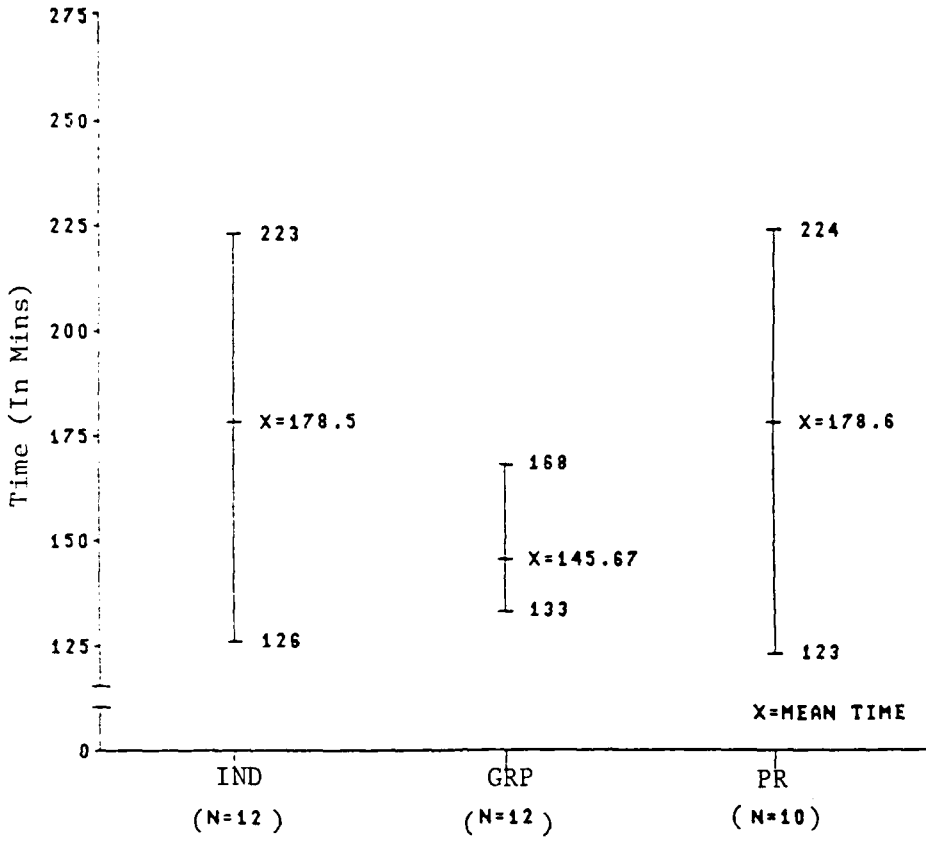

Figure 5. Experiment 2 range of times and mean times in minutes for the 34 soldiers to complete the courseware.

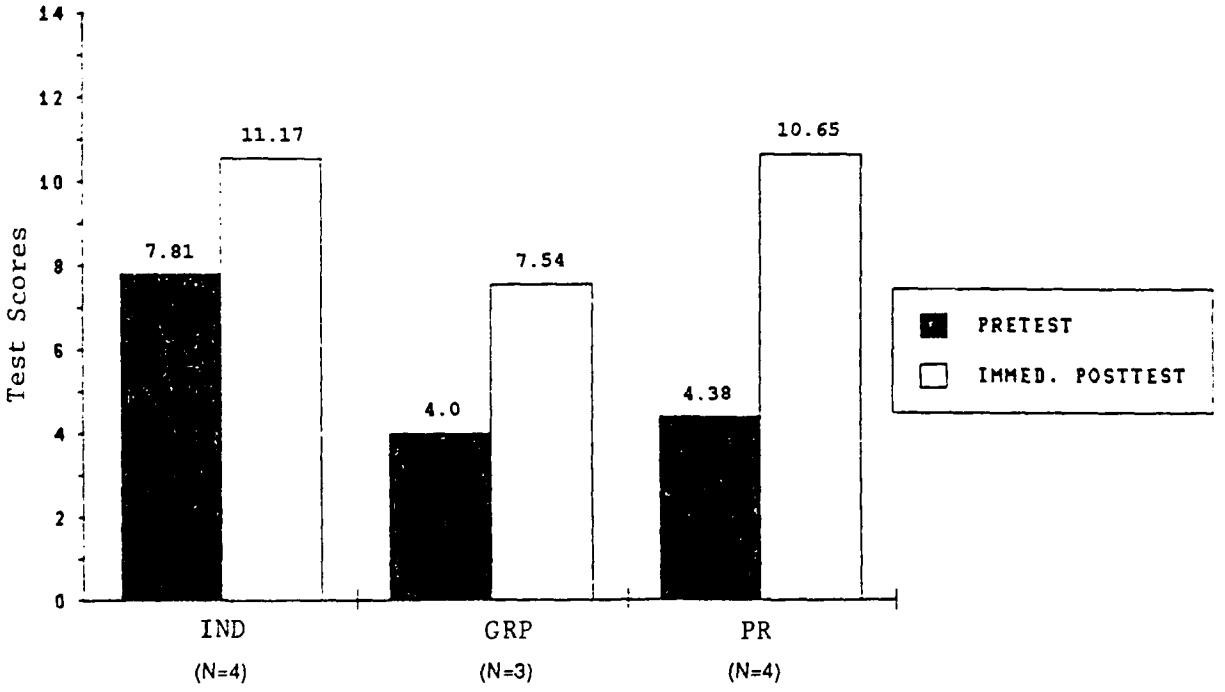

Figure 6. Experiment 2 mean pretest and immediate posttest scores for the low ability soldiers.

3. Achievement scores (immediate posttest scores)

4. Wrong responses to the exercises

5. Amount of proctor assistance

Learning efficiency indexes of 28.69 were found for the GRP condition and 5.89 for the IND condition. These results were associated with a reliable difference ($t(14) = 2.80$, $p<.05$) in the soldiers' time scores. The IND soldiers' time was nearly 33 minutes more than the average time for the GRP soldiers. The IND soldiers' learning times also were the most variable.

The learning efficiency data also showed that the IND soldiers requested proctor assistance 34 times, as compared to two such requests by the GRP soldiers. Also, the IND soldiers averaged 9.75 wrong responses to the computer exercises as compared to an average of 5.33 for the GRP soldiers.

Data for the Lower Ability Soldiers in the GRP and IND Conditions. As indicated in Figure 6, the average learning rate was 3.54 for lower ability GRP soldiers and 3.36 for IND soldiers. This difference occurred despite the fact that the IND soldiers had more practice in performing the tasks. The lower ability soldiers in the GRP condition also needed less time and less proctor assistance to complete the lesson: The GRP soldiers averaged 145.66 minutes and .33 requests for proctor assistance, and the IND soldiers averaged 189.25 minutes and 3.75 requests for proctor assistance. The results have thus suggested the relative effectiveness of group CBI for training lower ability soldiers. Because of the limited sample, however, this conclusion must be viewed as tentative.

Data for GRP versus PR Soldiers. Learning efficiency indexes of 28.69 and 11.43 were found for the GRP and PR training conditions. This difference was related to reliable differences ($t(14) = 2.70$ $p<.05$) in the soldiers' time scores. The average PR soldiers' time averaged 33 more minutes than did the GRP soldiers' (see Figure 2).

The lower ability soldiers in the PR condition, however, had a learning rate of 6.27 as compared to 3.43 for the GRP soldiers. Paired CBI may be more effective than group CBI for helping lower ability soldiers master the instructional material.

SUMMARY AND IMPLICATIONS

This investigation provided support for using group CBI over individual CBI. Group presentation of CBI materials was shown to be more cost effective than individual CBI. More students were able to receive CBI under group presentation with increased

efficiency in their ability to complete the computer lesson. Group CBI would also help instructors with scheduling their students for CBI use.

Fewer instructional resources would be needed with group CBI use. Group CBI would require the use of fewer CBI terminals when instructing similiar numbers of students. Fewer proctors would also be needed with group CBT. The data demonstrated that the group training soldiers had little need for any proctor intervention, while the individual training soldiers needed continuous help from the proctor. The instructional advantages of group CBI cited above held for both the acquisition and sustainment training programs.

Group CBI was also shown to be more effective for dealing with other instructional issues examined in this investigation. As reported, the IND soldiers in both experiments exhibited more forgetting than did PR soldiers. These retention differences would probably have been more pronounced if the amount of practice received for each soldier had been identical. The notion that group CBI was more effective for training lower ability soldiers also was supported.

This investigation and Shlechter's (1987a) findings have also suggested that cooperative learning is a natural consequence of grouping soldiers at a terminal. Talking about and helping each other with the instructional materials were prevalent within the GRP and PR conditions. Such cooperative learning seems to be the key factor for the instructional effectiveness of group CBI.

This investigation has also indicated that group CBI may be preferable to paired CBI. The GRP soldiers completed the courseware in less time and at the same learning rate than did the PR soldiers. Paired CBI was, however, the more optimal method for lower ability soldiers. Perhaps these latter findings was a function of pairing lower ability soldiers with higher ability soldiers. Higher ability soldiers used their expertise to help the lower ability soldiers. Even though these conclusions are based upon limited data, military instructors should consider pairing a lower ability soldier with a higher ability soldier.

The following implications can be drawn from this investigation's findings:

1. Group CBI seems to be a more efficient instructional mode than individualized and paired CBI for training procedural tasks.

2. Group CBI seems to lead to more effective retention of procedural information than did individualized CBI.

3. Group CBI appears to be more efficient than individualized CBI for training lower ability soldiers.

4. Instructors should consider pairing at terminals lower ability students with higher ability students.

5. Additional research should examine the generalizibility of the conclusions to other kinds of military tasks and learning situations. An investigation should be done, for example, on the generalizibility of this investigation's findings to an Advanced Armor Officer Course on tactics.

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APPENDIX A

SAMPLE OF THE TESTS USED IN THIS INVESTIGATION

FOR RESEARCH USE ONLY

SUBJECT NUMBER_____ DATE _____

CEOI PRETEST

This is a pretest for the CEOI computer lessons. During this test you will be required to answer questions about the CEOI and locate information in it. You have forty minutes to complete this test and try to do your best.

1. List in the space below the different types of information provided to individuals and units in the CEOI.

2. Which is NOT a method of physical security for the CEOI? (circle the correct answer)

a. keeping messages short.

b. changing the code every time period.

c. keeping it in a buttoned packet.

d. leaving it in your vehicle.

Use the following situation to answer the remaining questions--You are the 4th tank, 3rd Platoon, Co B, 2nd Sqd, 14th Cav. Contact the Plt Leader, 1st Platoon, Co C, 1st Bn 14th Armor. Time Period 7. Write your answer for each item in the space provided.

3. What is your unit item number?

4. Write down your complete call sign.

5. Write down the complete call sign of the unit that you are calling.

6. Write down the suffix and radio frequency of the unit that you are calling.

7. Write down the abbreviated call sign of the unit that you are calling.

8. Write down the correct statement for requesting permission to enter the radio net of the unit that you are calling.

9. Respond to the following authentication challenge, "RP."

10. The station you are calling asks you to identify your station. Enter the identifier that you would send after saying

"refer to." (Do not enter any prowords).

11. Encode the following message:
"Cross check point number 5 at 1100.

12. Encode the following messge:
"Extensive damage to fuel oil trucks."

13. Decode the following message:
"SUQ PKC EJY KUB LTH"

14. Complete the following grid coordination task:
I Set MM
Encrypt: JS 784391

SUBJECT NUMBER_____ DATE _____

CEOI POSTTEST VERSION A

This is a posttest for the CEOI computer lessons. During this test you will be required to answer questions about the CEOI and locate information in it. You have forty minutes to complete this test and try to do your best.

1. List below the different types of information provided to individuals and units in the CEOI.

2. Which is NOT a method of physical security for the CEOI? (circle the correct answer)

a. keeping messages short.

b. changing the code every time period.

c. keeping it in a buttoned packet.

d. leaving it in your vehicle.

Use the following situation to answer the remaining questions-- You are the Plt Leader, 2nd Platoon, Co A, 1st Bn 14th Armor. Contact the 1st tank, 1st Platoon, Co A, 2nd Sqd 14th Cav. Time Period 5. Write your answer for each item in the space provided.

3. What is your unit item number?

4. Write down your complete call sign.

5. Write down the complete call sign of the unit that you are calling.

6. Write down the suffix and radio frequency of the unit that you are calling.

7. Write down the abbreviated call sign of the unit that you are calling.

8. Write down the correct statement for requesting permission to enter the radio net of the unit that you are calling.

9. Respond to the following authentication challenge, "IM."

10. The station you are calling asks you to identify your station. Enter the identifier that you would send after saying "refer to." (Do not enter any prowords).

11. Encode the following message:
"Cross check point number 4 at 0925.

12. Encode the following messge:
"Enemy vehicles attacking battle position 08."

13. Decode the following message:
"JCM ERQ KHK WAQ LHU"

14. Complete the following grid coordination task:
I Set EL
Encrypt: TM 26115

FOR RESEARCH USE ONLY

SUBJECT NUMBER_____ DATE_____

CEOI POSTTEST VERSION B

This is a posttest for the CEOI computer lessons. During this test you will be required to answer questions about the CEOI and locate information in it. You have forty minutes to complete the test and try to do your best.

1. List below the different types of information provided to individuals and units in the CEOI.

2. Which is NOT a method of physical security for the CEOI? (circle the correct answer)

a. leaving it in your vehicle.
b. changing the code every time period.
c. keeping it in a buttoned packet.
d. keeping messages short.

Use the following situation to answer the remaining questions--You are the 3rd tank, 1st Platoon, Co C, 1st Bn 14th Armor. Contact the Platoon SGT, 2nd Platoon, Co B, 2nd Sqd 14th Cav. Time Period 9. Write your answer for each item in the space provided.

3. What is your unit item number?

4. Write down your complete call sign.

5. Write down the complete call sign of the unit that you are calling.

6. Write down the suffix and radio frequency of the unit that you are calling.

7. Write down the abbreviated call sign of the unit that you are calling.

8. Write down the correct statement for requesting permission to enter the radio net of the unit that you are calling.

9. Respond to the following authentication challenge, "JT".

10. The station you are calling asks you to identify your station. Enter the identifier that you would send after saying "refer to". (Do not enter any prowords).

11. Encode the following message:

"Cross check point number 10 at 0740.

12. Encode the following message:

"Searching for disabled enemy vehicles".

13. Decode the following message:

    'VNF GKW IUZ DNG YZI'

14. Complete the following grid coordination task:

    I Set GO

    Encrypt: RC 844730

SUBJECT NUMBER_____ DATE _____

CEOI POSTTEST VERSION C

This is a posttest for the CEOI computer lessons. During this test you will be required to answer questions about the CEOI and locate information in it. You have forty minutes to complete this test and try to do your best.

1. List below the different types of information provided to individuals and units in the CEOI.

2. Which is NOT a method of physical security for the CEOI? (circle the correct answer)

a. changing the code every time period.

b. leaving it in your vehicle.

c. keeping it in a buttoned packet.

d. keeping messages short.

Use the following situation to answer the remaining questions-- You are the Platoon Sgt, 2nd Platoon, Co C, 1st Bn 14th Armor. Contact the 4th tank,3rd Platoon, Co A, 2nd Sqd 14th Cav. Time Period 6. Write your answer for each item in the space provided.

3. What is your unit item number?

4. Write down your complete call sign.

5. Write down the complete call sign of the individual that you are calling.

6. Write down the suffix and radio frequency of the individual that you are calling.

7. Write down the abbreviated call sign of the individual that you are calling.

8. Write down the correct statement for requesting permission to enter the radio net of the unit that you are calling.

9. Respond to the following authentication challenge, "JT."

10. The station you are calling asks you to identify your station. Enter the identifier that you would send after saying "refer to." (Do not enter any prowords).

11. Encode the following message:
"Cross check point number 12 at 1315.

12. Encode the following messge:
"Observed damage to enemy vehicles."

13. Decode the following message:
    "MFF CGG KHK XNC OBO

14. Complete the following grid coordination task:
    I Set NB

    Encrypt: JS 784391

APPENDIX B

CORRELATIONAL RESULTS FOR EXPERIMENT 1.

	Pretest Scores	Imm Postest Scores	Del Postest Scores	Ret Scores
GT scores	-.28	.26	.21	.13
Time in Service	.13	.01	.16	-.25
No. of Ss Using CEOI	.44	.18	.25	-.11
Average Use of CEOI	.55	.24	.32	-.10
Intervening CEOI use between sessions	----	----	----	.12

n=24
Critical value for two-tail test = .40
Critical value for one-tail test = .3

APPENDIX C

CORRELATIONAL RESULTS FOR EXPERIMENT 2
CORRELATIONAL RESULTS FOR THE SAMPLE OF 34 SOLDIERS

	Pretest Scores	Imm Postest Scores
GT scores	.47	.24
Time in Service	.09	.01
Tank Exp.	.16	.01
TC Exp.	.04	.25
No. of Ss Using CEOI	-.22	.18
Average Use of CEOI	-.05	.24

n=34
Critical value for two-tail test = .34
Critical value for one-tail test = .29

APPENDIX C (Con'd)

CORRELATIONAL RESULTS FOR SAMPLE OF 28 SOLDIERS

	Pretest Scores	Imm Postest Scores
GT scores	.52	.22
Time in Service	.18	.25
Tank Exp.	.25	-.09
TC Exp.	.05	-.19
No. of Ss Using CEOI	-.23	-.10
Average Use of CEOI	-.04	.09

n=28
Critical value for two-tail test = .38
Critical value for one-tail test = .32

APPENDIX C (Con'd)

CORRELATIONAL RESULTS FOR SAMPLE OF 28 SOLDIERS

	Delay 1* Scores	Delay 2 Scores	Ret 1 Scores	Ret 2 Scores	Ret 3 Scores
GT scores	.15	.14	.16	.01	.14
Time in Service	-.19	.10	.07	-.25	-.07
Tank Exp.	-.02	-.16	.00	.11	.08
TC Exp.	.08	-.10	-.26	.15	-.12
No. of Ss Using CEOI	-.03	-.35	-.09	.26	-.10
Average Use of CEOI	.02	-.01	.10	.02	.09
Intervening CEOI use during ret. interval 1	.20	.22	.02	-.01	.02
Intervening CEOI use during ret. interval 2	-----	.19	----	-.14	.07

n=28
Critical value for two-tail test = .38
Critical value for one-tail test = .31
*These labels refer in the following way to the different measures: delay 1= two-week delayed posttest; delay 2=two-month delayed posttest; ret 1= initial two-week retention interval; ret 2 = six-week retention interval between delayed posttests; and ret 3= two-month retention interval from immediate posttest to second delayed posttest.